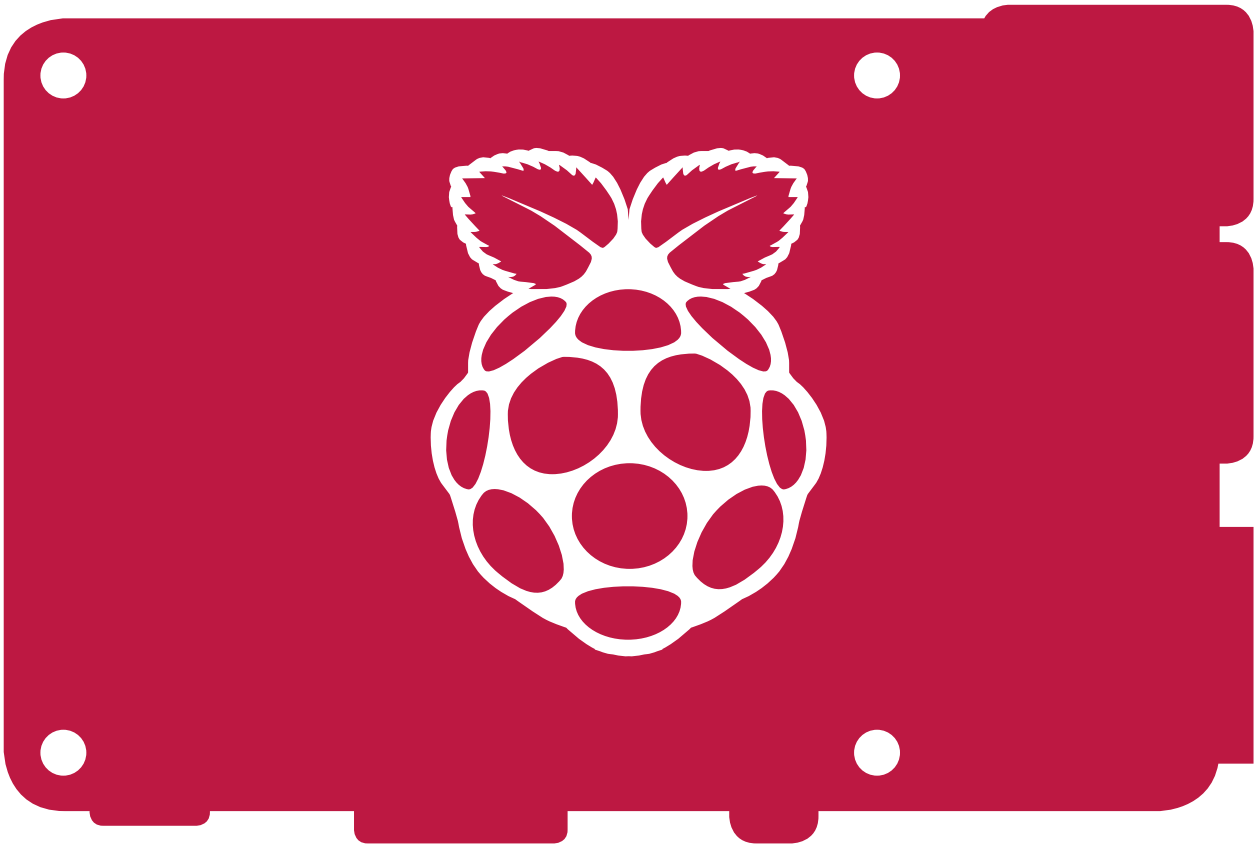


RASPBERRY PI B+

Two computers, one SoC. **Ben Everard** takes a look at the new Raspberry Pi that ships with the old processor.

On Monday 14 July, The Raspberry Pi Foundation officially announced the biggest change to the design of the Raspberry Pi model B since its launch at the start of 2012: the model B+. In a surprise to some, the new Pi doesn't have a new processor or any more memory than the previous revision. However, many things around the System on a Chip (SoC) have changed.

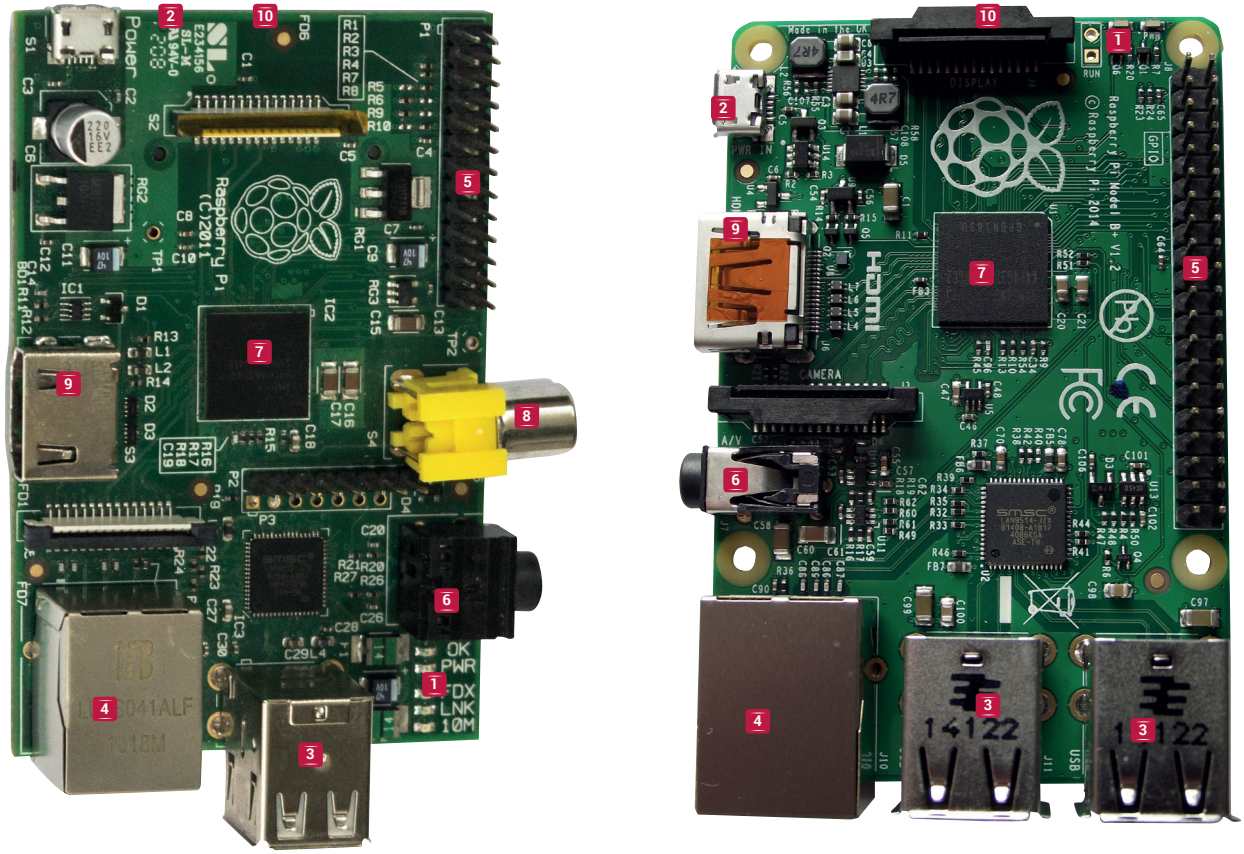
The new version is almost exactly the same size as before, but again there have been a number of important tweaks to the physical design. The corners are now rounded; the connectors only lead off two sides; the USB ports no longer stick out; and the mounting holes are now in a rectangle. These mounting holes are also used to support expansion boards, making a far more secure attachment than relying on GPIOs alone (as most did previously).

"The differences between the B and B+ are important, and add up to a much better computer."

These are all cosmetic changes, but together they do make the device nice to use. Perhaps the biggest beneficiary of these changes aren't normal users, but the people making boxes and enclosures for the Pi.

If you're used to thinking about computer performance in terms of the usual metrics of

Side by side The changes mapped out



1 Status LEDs The Power and ACT LEDs have moved to a new position on the board and the network LEDs on the B+ are on the network port.

2 Power Supply The B+ is still powered by the same micro USB power supply; however it uses the power more efficiently, so it's less prone to power-related problems than the model B.

3 USBs Thanks to the improved power supply, the USBs on the B+ are capable of running higher-powered peripherals, though a powered USB hub is still recommended if you're using anything with a significant power draw.

4 Ethernet The B+ still connects Ethernet through the USB hub, so speeds can be affected by heavy USB usage. The network status LEDs are now on the Ethernet port.

5 GPIO Pad 1 This has been expanded from 26 to 40 pins. The top 26 pins are identical on both the B and B+, so and boards that connect to them should work on both. However, some boards designed for the B (such as the PiFace) fit closely around the raised components may not physically fit onto the B+ unless you add something to raise the GPIOs.

6 Audio The audio output on the model B isn't very good. The B+ improves this dramatically, and is good enough for most applications.

7 SoC and Memory These are exactly the same on the B and B+, so performance should be identical.

8 Composite Video On the B this had its own connector, but on the B+ it's on the fourth pole of the audio jack. This means you'll need the appropriate cable to connect it to a TV.

9 HDMI HDMI video and audio is unchanged.

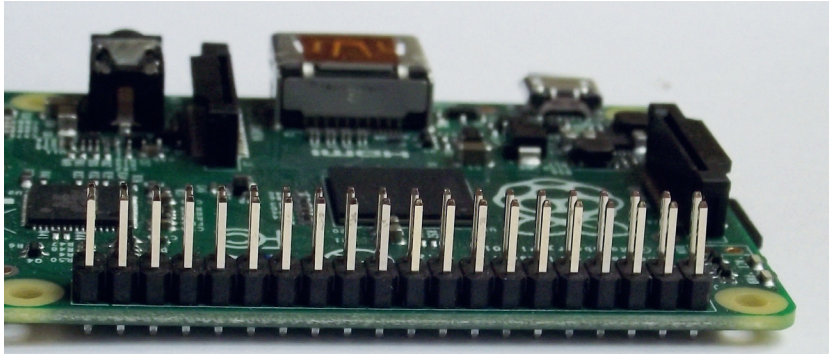
10 SD Card The B+ uses a micro SD card rather than the full sized SD card. A micro SD card will work in a model B as long as it's inside an adaptor.

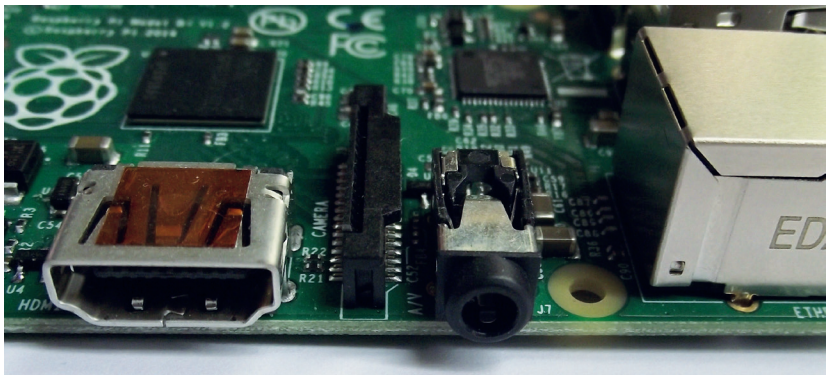
processing power or amount of memory, it would be easy to pass over the differences between the B and the B+. This is a mistake. The differences are important, and add up to a much better computer despite the fact that, underneath it all, it still has the same engine.

The key to the new board is the new regulator. A regulator is a device that adjusts the voltage from a higher voltage down to a lower one. There are several on the Pi, but the main one converts the 5V that comes in from the micro USB power supply into 3.3V that's used on many of the components. The original model B had a linear regulator, which is basically a device that converts the difference between the input voltage and the output voltage into heat. This is highly inefficient, but linear regulators are cheap and simple to use.

The B+ has a switching regulator. This actually converts the input energy at one voltage to a new output voltage. They still waste a little power, because no component is 100% efficient, but far more power makes it through than does with linear regulators.

The 40 GPIOs on the B+ feature 15 PWM channels, one UART, one SPI, one I2C, and one connection to header flash, plus 26 programmable pins.





As well as producing better sound, the B+'s new AV jack looks a lot better than the hulking black monstrosity that was on the Model B.

The new regulator saves between half a watt and one watt of power. This, by itself, isn't very important – it's not a big enough difference that you'll notice lower electricity bills. It will, however, have an impact on anyone running their Pi off solar power or batteries, but this isn't the main reason we're excited about the lower power usage. Most USB power supplies can deliver between one and two amps at 5V, with many of the more common ones being much closer to 1A than 2A. At 1A, this means there's 5 watts of power for the Pi, so the saving is equivalent to 10–20% of the total power available.

By wasting less power, the model B+ effectively makes more power available for peripherals. This 10–20% increase is the difference between the model B not being able to handle and unpowered hub with a mouse keyboard and USB memory stick and the B+ being able to.

Making connections

On the board itself, the thing that stands out more than anything is the addition of two USB ports. This has been made possible by replacing the Lan9512 USB to Ethernet chip with a Lan9514. The bad news is that this still sends Ethernet and USB traffic over the same bus to the SoC, so if you connect high-bandwidth USB devices and a network connection, you will notice the speeds slowing down.

The good news is that the improved power supply on the B+ means that the USB ports are quite usable for low-power devices without an external powered hub. We had no problems at all with just a mouse and keyboard. A mouse, keyboard and USB memory stick also worked fine. A mouse, keyboard and two memory sticks did work, though the power to the mouse dropped out when both the memory sticks were active. We had some success with a USB web cam, though for this and anything higher power (such as a USB hard drive) we'd still recommend using a powered hub.

The exact number of devices you can drive will depend on the power supply your using. The above was tested with a supply rated at 1A. More powerful supplies are available and these will be able to pass on the extra power to the USB ports.

We can't give any hard-and-fast rules, but previously we advised anyone getting a Pi to get a powered USB hub as well (unless it was for an embedded project). Now, our advice has changed to: only get a powered USB hub if you find you need one.

Making music

Let's be honest, the analogue audio on the model B was terrible. It was okay if you just wanted to make a few noises and didn't really care what they sounded like, but for anything more than that, you needed something extra.

The audio over HDMI worked fine, so home theatre systems didn't have a problem. However, many monitors don't have inbuilt sound (or at least not very good inbuilt sound). With the Pi Foundation pushing the musical programming language Sonic Pi (**www.cl.cam.ac.uk/projects/raspberrypi/sonicpi/index.html – and indeed on page 78 of this magazine**) as a way to get children interested in programming, the poor audio performance over the headphone port needed to be addressed.

To test the audio, we've had a B+ plugged into our stereo running *XBMC* (see Distrohopper on page 8) for the past two weeks. So far, we haven't noticed any difference between the quality of the B+ and the quality of the sound out of the CD player. Of course, true audiophiles seeking top-quality sounds aren't going to get them from the audio output of a Pi (or anything else that sells for £30, for that matter). The Wolfson Audio Card for the B will no longer work on the B+, because it relies on the P5 GPIOs, which are no longer available.

The B+ has 14 more pins in the GPIO header, but that doesn't mean there are 14 extra programmable outputs. Only nine of these pins are programmable, three are ground and two are reserved for communicating with HATs (see boxout, left).

Hardware Attached on Top (HATs) A new way to configure add-ons

The Raspberry Pi's GPIOs allow programmers access to pins that they can both write to and read from. They also allow hardware manufacturers to create add-ons that use these GPIOs to communicate with the processor. There are a number of additional functions – such as I2C and SPI communications channels – that can be accessed through these pins. However, at present, the process of setting these up is a little awkward.

With the B+, the Raspberry Pi Foundation has introduced what it calls HATs (Hardware Attached on Top). For a device to be classified as a HAT, it has to conform to a set of standards designed to make sure it behaves itself when communicating with the Pi. Expansion boards don't have to conform to the HAT standard to work on a Pi, but they can't call themselves HATs if they don't.

The most important of these standards is that devices must contain an EEPROM (a bit of memory that the Pi can read). This can be used to tell the Pi a bit about what the device does, and how the GPIO pins should be configured to work properly with the Pi. In technical terms, the EEPROM should contain a device tree that can be loaded by the kernel and will set up the GPIOs correctly. At the time of writing, no HATs are available, though manufacturers will of course be working on them. It's too early to say if they will become popular. We suspect that there will continue to be a significant market for B-style 26-pin boards without EEPROMs. These will be significantly cheaper to manufacture because they won't need as much PCS space if they only cover 26 pins (PCBs are surprisingly expensive, especially for small production runs). The more advanced capabilities won't be needed by many, especially if they only rely on turning GPIOs on and off rather than using a communications protocol. Though the most persuasive reason for hrdware manufacturers to keep making devices for the Model B is that there are around 3,000,000 model B's in circulation and they aren't going to be replaced overnight.

A few extra GPIOs aren't usually that important, especially as they don't include any additional support for low-level communications protocols. There's still one each of serial, I2C and SPI. It's easy enough to use the existing I2C or SPI busses to add more GPIOs anyway should you need to, and this is what many add-ons do, as it also protects the Pi from damage due to electrical problems in the circuit they're connected to. Boards like the Protect Your Pi by My Pi (**www.modmypi.com/protect-your-pi**) use these to provide more GPIOs than the Pi actually has.

However, using these port expanders slows down the speed at which you can turn the GPIOs on and off. This is almost imperceptible if you're just using them to turn LEDs on, or get input from a button, but if you're using them to connect to some other electronics, the delay can be too much. An extra nine GPIOs is enough to be able to implement some communications protocols that require 26 channels, such as those to drive some LCD displays, so it increases the Pi's potential enormously.

What's next?

Eben Upton, founder of the Raspbery Pi Foundation, has confirmed to us that the Foundation is looking into a model A+, which will do to the model A what the B+ has done to the B. We haven't heard exactly what form this will take yet, but we suspect that some people are particularly interested in a model A with a switching regulator, since this will be even more power efficient than the B+, making it the ideal device for running on batteries (the Model A is used in many embedded projects).

Beyond this, many people are waiting for a version of the Raspberry Pi with more processing power or memory than those currently available, sometimes called the Model C (though people inside the Raspberry Pi Foundation refer to this as the Raspberry Pi 2). It should be obvious by now that the brains at the Pi Foundation aren't interested in constantly chasing the latest hardware – they are more concerned with providing a stable base and developing software to use it efficiently. Schools – which are the primary target of the Raspberry Pi – don't want to have to spend time and money to change their hardware every year or two just to be able to follow the latest projects.

Having a slow release cycle also helps companies making add-on boards. It enables them to spend time understanding a product, learning what the users want, and designing something properly rather than just rushing to market because it may be obsolete soon.

The next version of the Pi is expected in 2017, but don't expect it to be the most powerful ARM board on the market. However, it will be well supported with a large number of add-ons, it will have a large community behind it, and it will be developed by an organisation with the resources to make sure it runs well.

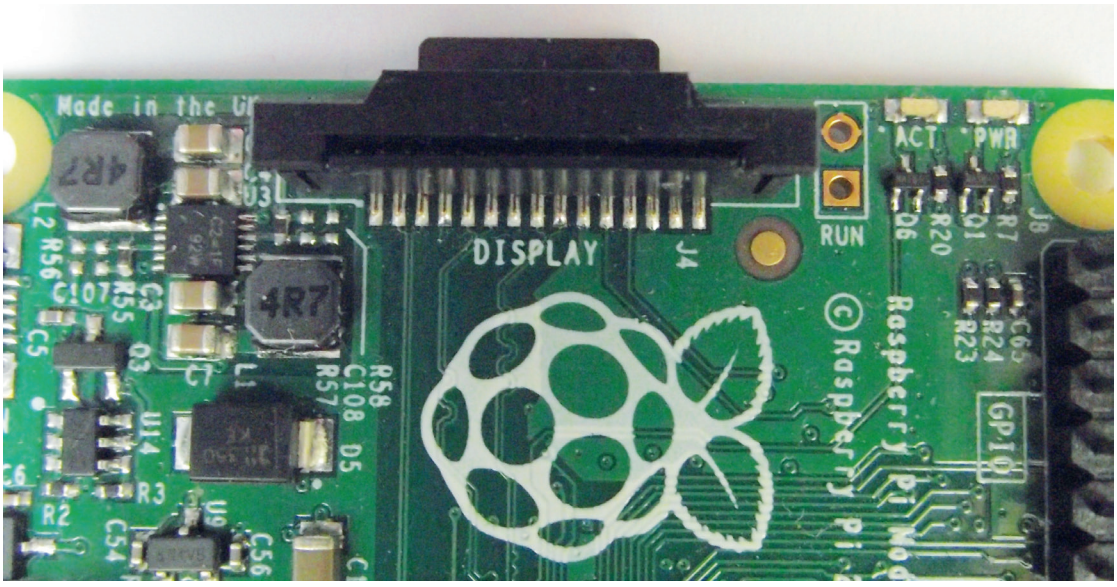
Shrinking storage

Of all the changes, perhaps the most superficial is the switch from full-sized to micro SD cards. The two formats are the same from an electrical point of view, so it shouldn't have any impact on speed. In fact, it's perfectly possible to use a micro SD card with a model B if you put it in an adaptor (which many micro USB cards come with). These adaptors also make it possible to copy data onto the small cards from computers that only have full-sized SD card slots.

The only real difference between the two (other than size of course) is that micro SD cards have a barb that can be used to hold the card in place, which should make it a bit more reliable if the Pi's being moved around.

The B+ gives us a number of improvements, but still keeps almost complete compatibility with the older device. We used the word almost because of the lack of Pad 5 GPIO, but this didn't get much use anyway. We're sure that a few people will be disappointed by lack of a new processor or more memory, but in a way, we're not. The Raspberry Pi is great because it's a stable platform we can build projects on and know they'll work when recreated by other people. As model B owners, we're delighted to know that all the software from the Foundation and community will still run on our devices, and as B+ owners we're pleased that some of the niggling problems of the Model B have been solved. Now let's get building!

"We're delighted that all the software from the Foundation and community will still run on the Model B+."



There's now a connector labelled as the display waiting for the official display module.